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On the Reaction of *Amphipyra* Moths (Lepidoptera, Noctuidae) to the Light

Shintaro FUNAKOSHI

1-25, Namazu Naigucho, Hozumicho, Motoshugun, Gifu, 501-02 Japan

Introduction

Adults of some *Amphipyra* emerge in early summer and spend in their aestivating sites for several months. The aestivating adults leave the sites between late summer and late autumn, and there seems to be differences in the aestivation period among species.

In the present study, the activities of *Amphipyra* species were studied in the laboratory and the reaction of aestivating individuals to the light was investigated in the field.

Materials and Methods

Experiment 1. Adults (17♂19♀) of *A. livida* resting in a shrine and those (3♂1♀) attracted light were captured at the foot of Mt. Dodogamine (altitude: 341.5m), Gifu city, on the 28th June, 5th July, and 12th July, 1987. These adults were reared in an incubator at 20°C with black sugar solution as bait. For experiments, they were singly separated into wire-gauzed wooden boxes of 11.5×11.5×5.5cm. Their movement was

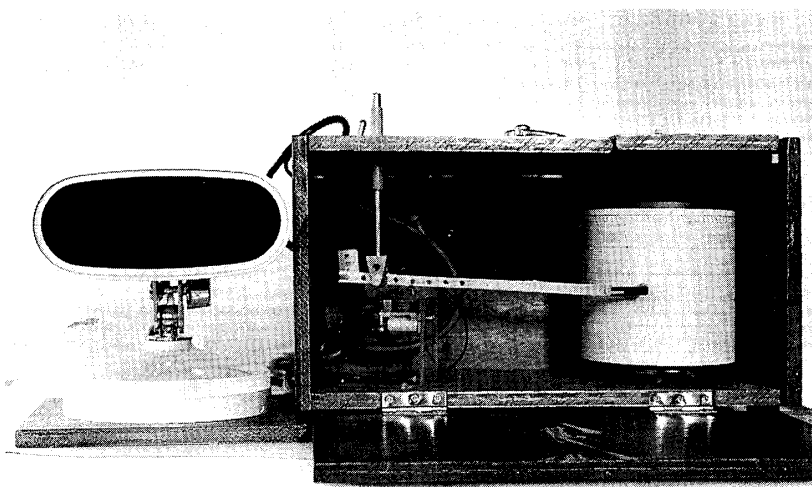


Fig.1. Equipment for the experiment 1. Right : sender of infrared rays. Left : kimo-graph.

recorded all night by the kimograph using infrared rays (Fig. 1). Records were taken under natural light and continuous illumination offered by a 20W fluorescent lamp.

Experiment 2. A 100W mercury lamp was set against the background of $2.4 \times 1.9\text{m}$ white cloth in front of a building of the Shinmey shrine at Miyama-cho, Gifu Pref, on 1st August, and also of the Hakusan shrine at Gifu-city on 19th September, 1987. After the species, numbers, and positions of *Amphipyra* moths on the eaves of each shrine were recorded, the lamp was lighted on from 20 : 00 till 21 : 00 and flying individuals were captured. One hour after that, the lamp was turned off and individuals resting on the eaves were counted again.

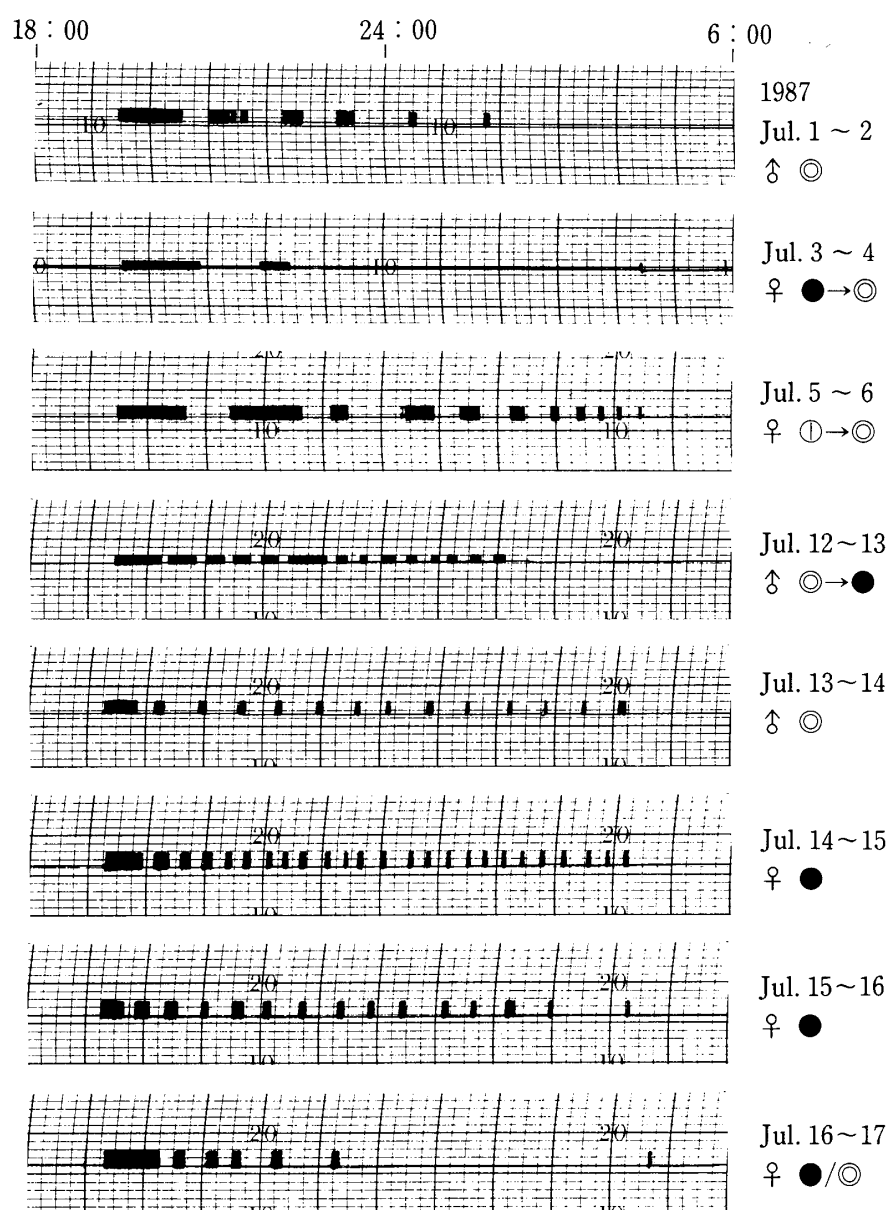


Fig.2. Moth activity recorded by kimograph. Individuals collected from shelter, under natural light. Date, sex and weather are shown on the night end.

Table 1. Variation of aestivating moths before and after lightning on.

date place	species	before lightning	after lightning	flying to the light
1, Aug. 1987	<i>A. livida</i>	4	4	0
Miyama-cho	<i>A. erebina</i>	17	8	14
	<i>A. schrenckii</i>	6	5	0
19, Sep. 1987	<i>A. livida</i>	14	14	0
Gifu-city	<i>A. monolitha</i>	12	12	0

Results

Fig. 2 shows the results of experiment 1, in which the hand of kimograph was swang due to the moth moving across the infrared beam. All the moths individuals were kept inactive under the continuous lightning, irrespective of their behaviour shown in the original sites.

Under natural lightning conditions, the moth movement was started at about 19:30 and stopped by about 4:30 the next morning. The moths came to intermittent flights, except for a few of them which took continuous activity. Again, there was no significant difference between the individuals attracted to light and those in rest at the collecting time in the field.

Table 1 shows the results of experiment 2. Fig3-1, 1' shows resting sites of the aestivation adults before lightning and fig3-2, 2' after lightning. When the lamp was switched on, all the individuals resting on the eaves were suddenly exposed to the light from the lamp. Many adults of *A. erebina* came flying to the light on early August. The number of individuals in flight during the illumination and those observed on the eaves after its turn-off exceeded the initial number counted on the eaves before the lightning. On the other hand, none of *A. livida*, *A. schrenckii*, and *A. monolitha*, came flying to the light. In early August, very few individuals of these species were only slightly locomotive in the aestivation sites. This situation would continue still in mid September, as the present results suggest.

Discussion

TUGANE (1975) revealed the life cycle of *A. livida* and showed the developmental zeropoint, the effective day-degree, the seasonal population to the light and aestivation period in Mie Pref.. FUNAKOSHI (1985) found that *A. erebina* disappeared from the aestivation sites by late August, whereas *A. monolitha* and *A. livida* remained there till the middle of November. Some of these *Amphipyra* moths came flying to the light even during the aestivation period. For example, many reports (BITO *et al.*, 1978; TAKEDA *et al.*, 1979; ENDO *et al.*, 1981; ENDO *et al.*, 1982; FUNAKOSHI, 1982; ANDO *et al.*, 1985; TOMIZAWA, 1987; WATANABE, 1987) indicated that the adults were occasionally

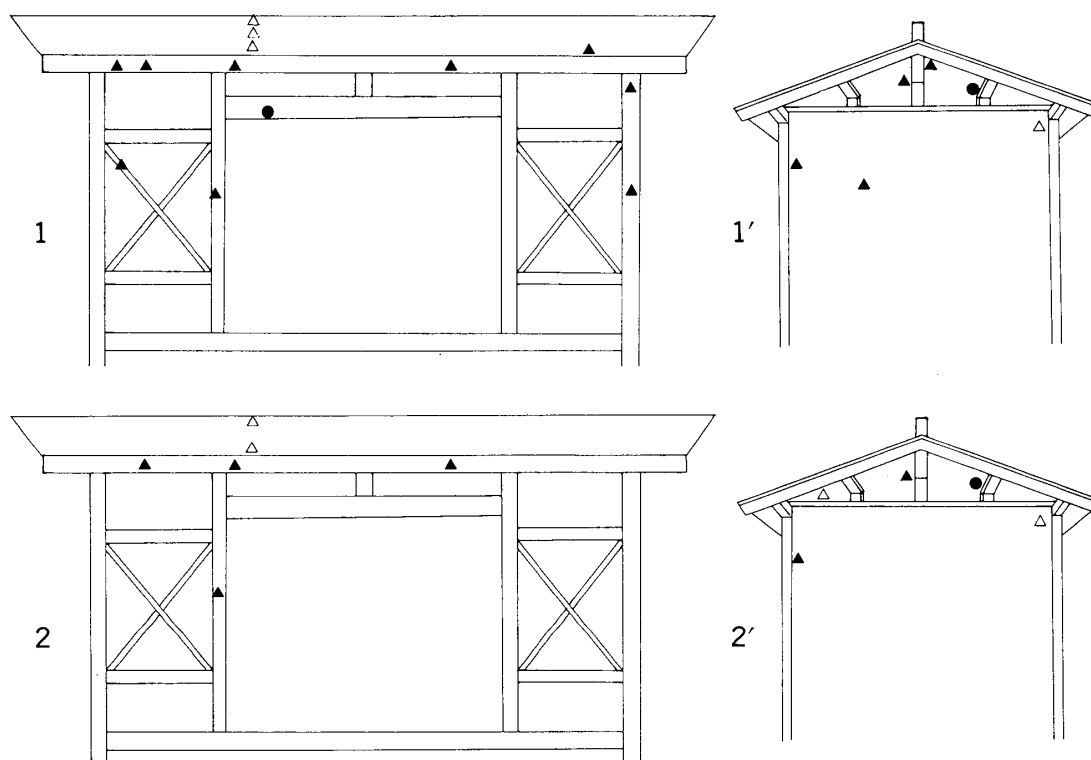


Fig.3. Distribution of resting adults in a building of the Shinmey Shrine at Miyama-cho, Gifu Pref., 1 Aug.1987. 1 & 1': Before lightning. 2 & 2': after lightning. Hollow triangle indicates *A. livida*, solid triangle *A. erebina*, and solid circle *A. schrenckii*; different sides of building are separately shown.

captured by light traps from July to September without clear interruption. But individuals captured by the light traps during the period were less than those in early summer and mid autumn at plain region in Tokai district. During the similar period of season of early August at Kikyogahara (altitude: ca.2700m) of Mt. Norikura, many adults of *A. pyramidea* were attracted to a mercury-vapour lamp, despite the fact that many others of the same species were kept inactive in a nearby aestivation sites with no reaction to the light. On the other hand, the all-day-around observation undertaken every 4-hour on the adults in aggregation under the eaves in a shrine at Miyama-cho, Yamagata-gun, Gifu Pref., some other species kept motionless or moved only slightly (FUNAKOSHI, 1984).

So far as hinted here, aestivating adults of *A. livida*, *A. schrenckii*, and *A. monolitha* did not come flying to the light both in early August and mid September. The results suggest that they may be in an intense diapause state during this period of season. On the other hand, the laboratory investigation showed that of *A. livida* collected in late June to mid July took intermittent flights all night, unless the

continuous lightning inhibited the flights. The discrepancy between the laboratory and field experiments with *A. livida* is presumably due to the difference in age of adults tested or intensity of light applied. Although the adults exhibited no clear activity in response to light in the experiment 2, there have been many occasional capture records of these species by light in the fields during the aestivation period. This suggests that there may be individual and local variations in light reaction and activity of them.

In contrast, *A. erebina* showed an active flight in reaction to the short term illumination at night even in the hottest season, early August, which is undoubtedly in the midst of aestivation. Thus, this species keeps higher activity in diapause period than the other *Amphipyra* mentioned above. The more pronounced activity in *A. erebina* may be linked with its shorter aestivation period. Similar linkage among constituent behaviours of diapause syndrome was suggested for other noctuids.

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摘 要

Amphipyra 属の蛾の光に対する反応について（船越進太郎）

ヤガ科カラスヨトウ亜科 *Amphipyra* 属の蛾は初夏に羽化した後、夏眠場所へ移動し数カ月を過ごす。夏眠期間は種によって異なり、オオウスヅマカラスヨトウ *A. erebina* が8月下旬に姿を消すのに対し、オオシマカラスヨトウ *A. monolitha* やカラスヨトウ *A. livida* の中には、11月中旬になっても夏眠場所に残るものがある。しかし、夏眠期間中にあっても光に誘引されるものがあり、7月から9月に至る期間、この属の蛾の採集記録は少なくない。そこで、光に誘引される個体は夏眠個体とは多少とも異なった生理状態にあるのではないかと考えて、この実験を行った。

材料は岐阜市三田洞の白山神社拝殿と同地域に位置する百々ヶ峰山（341.5 m）の中腹で採集した夏眠個体 36（17 ♂ 19 ♀）および光に誘引されたカラスヨトウ 4（3 ♂ 1 ♀）を用いた。これらの個体を黒砂糖溶液を与えながら飼育し、金網を張った木箱の中に一匹ずつ入れて赤外線を照射し、その動きをカイモグラフに記録した。実験は1987年6月30日より7月22日の間に行い、17時より翌朝8時までの活動状態を調べた。木箱は恒温室内に置き、温度や湿度を一定に保ち、自然光が入り込む条件および24時間照明の条件を設定した。

また、1987年8月1日、岐阜県山県郡美山町の神明神社および1987年9月19日、岐阜市三田洞の白山神社において、拝殿より約5 m離れた位置に100 W 水銀灯を設置した。拝殿軒下で夏眠する蛾の種、個体数、静止位置を記録した後、水銀灯を点灯した。点灯時間は1時間で、その間、光に飛来する個体を捕獲した。消灯後、再度軒下の個体を記録した。

以上の結果、室内実験において24時間照明下では、カラスヨトウの光誘引個体も夏眠個体も全く動かなかった。自然光下では19:30 前後より活動が始まり、多くの個体は断続的に活動したが、中には一晩中動き続ける個体があった。全ての個体は4:30 頃までに活動を停止した。しかし、夏眠個体と光誘引個体との間に行動の差違を見い出すことができなかった。

神社拝殿の夏眠個体の中で、8月上旬のオオウスヅマカラスヨトウは、大半が光に誘引された。しかし、カラスヨトウ、ツマジロカラスヨトウ *A. schrenckii*、オオシマカラスヨトウは全く誘引されず、多少静止位置を変えるものがあったが、夏眠を継続した。